Early consideration on the merits of the present application is now respectfully requested.

Respectfully submitted,

(Reg. No. 39,056)

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VERSIONS WITH MARKINGS TO SHOW CHANGES MADE

In The Specification:

The Specification of the present application, including the Abstract, has been amended as follows:

~~Description~~

~~Method for allocating at least one value of at least one transmission parameter to cells in a communications arrangement having m cells~~

SPECIFICATION

TITLE

METHOD FOR ALLOCATING AT LEAST ONE VALUE OF AT LEAST ONE TRANSMISSION PARAMETER TO CELLS IN A COMMUNICATIONS SYSTEM HAVING m CELLS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates, generally, to method for allocating at least one value of at least one transmission parameter to cells in a communication system having m cells and, more particularly, to such a method wherein a disturbance value is respectively determined for non-adjacent cells and an overall disturbance value representing a total of all such disturbance values is formed, and weighted, and a minimum overall disturbance value is ultimately reached.

Description of the Prior Art

In wire-free communications networks based on radio channels, in particular for point-to-multipoint radio feeder networks ~~–~~ (also referred to as "radio in the local loop" or "RLL"), ~~-~~ a number of network termination units are each connected via one or more radio channels to a base station ~~–~~ (also referred to as a "radio base station" or "RBS"). Telcom Report No. 18 (1995), issue 1 "Drahtlos zum Freizeichen" [Ringing without wires], pages 36, 37, for example, describes a wire-free feeder network for wire-free voice and data communication. The described communications system represents an RLL subscriber connection

in conjunction with a modern broadband infrastructure - for example "fiber to the curb" - which can be produced in a short time and without major effort, instead of laying wire-based connecting lines. The network termination units RNT – (Radio Network Termination) - allocated to the individual subscribers are connected via the "radio channel" transmission medium and the base station RBS to a higher-level communications network~~,~~; for example, to the ISDN-based landline network. As multimedia applications become increasingly widespread, high bit-rate data streams must be transmitted quickly and reliably via communications networks~~,~~; in particular, via wire-free communications networks or via mobile radio systems. Particularly with regard to the air interface, this necessitates the use of methods which can be implemented only with a great deal of effort, both technically and financially, for controlling access to the transmission medium, as well as the use of complex methods for multiplexing, coding and ~~modulation of~~ modulating the signals. For example, to provide the future third generation mobile communications systems, the cellular mobile radio, cordless telephone and radio paging systems, which are currently still separate, for voice and/or data transmission are combined in a universal mobile communications system, - also referred to as UMTS (Universal Mobile Telecommunications System), - thus allowing an increased range of services and standard terminals. To achieve this, a region which is to be supplied and which covers a large area, - for example Europe, - is split, in a similar way to that for cellular mobile radio, into partially overlapping radio cells of different sizes; - for example, into macro, micro and pico cells. – This is done in order to use the available frequency spectrum to cover the switching and transmission resources requirement~~,~~ which differs widely depending on the subregion; - for example, within a city or a rural region. Each radio cell is allocated a base station which is connected via the "radio channel" wire-free transmission medium to a number of decentralized communications devices such as mobile stations or wire-free network termination units. In order to allow bidirectional information transmission between the base station and a

decentralized communications device arranged in a radio cell in a wire-free communications system ~~arrangement~~, a duplex link is in each case set up between a decentralized communications device and a central base station, with either the FDD method – ("Frequency Division Duplex") - or the TDD method – ("Time Division Duplex") - being used as the current duplexing method for bidirectional information transmission. Multiple access methods, such as FDMA – (Frequency Division Multiple Access) -, TDMA – (Time Division Multiple Access) - and CDMA – (Code Division Multiple Access) - are used to control access to the jointly used "radio channel" transmission medium by the central and decentralized communications devices arranged in a wire-free communications system ~~arrangement~~. Furthermore, combinations of such ~~said~~ multiple access methods – (also referred to as hybrid methods) - such as the TD/CDMA access method, are known for use in future wire-free communications systems ~~arrangements~~.

In contrast to the FDMA and TDMA multiple access method, the CDMA multiple access method allows all the communications devices and subscribers arranged in a radio cell or cell in the wire-free communications ~~arrangement~~ system to use the same frequency band at the same time. To allow the subscriber signals transmitted by the individual communications devices to be separable at the receiver end, these signals are spread spectrally; ~~, that is to say~~ i.e., they are transformed in a broadband spectral band. One method for spectral spreading is, for example, the DS principle "Direct Sequence" which is frequently used in present-day mobile communication and in which each narrowband subscriber signal at a low bit rate is multiplied, for spectral spreading, by a broadband spreading function which is allocated individually to the subscriber and which is ~~also~~ referred to as the CDMA code. The broadband signal which results from this contains the narrowband user signal or subscriber signal and an individual fine structure, using which the user signal or subscriber signal can be separated at the receiver end from the other superimposed, broadband transmission signals.

During network planning or network expansion of code-selective radio systems, that is to say when implementing wire-free cellular communications networks using the CDMA multiple access method, each base station or central communications device which produces a radio cell must be allocated a base-station specific CDMA code which represents a spreading function. A CDMA code allocated to a base station is also referred to as a CDMA basic code or CDMA code name since this is, in each case, used to derive those cell-specific CDMA codes which are allocated to the decentralized communications devices arranged in the respective radio cell in order to provide radio channels when setting up a link. The CDMA basic codes and the CDMA codes derived from the CDMA basic codes and used for the CDMA multiple access method within the radio cell may represent both orthogonal and non-orthogonal CDMA codes. In such ~~, in which~~ case, orthogonal CDMA codes are independent of one another - ~~that is to say~~ (i.e., the value of the cross-correlation between two orthogonal CDMA codes has the value 0), wherein ~~-;~~ non-orthogonal CDMA codes have a cross-correlation which differs slightly from the value 0.

When producing or expanding wire-free cellular communications networks based on a CDMA multiple access method, the CDMA basic codes, of which only a limited number are available, must be distributed between the base stations arranged in the radio cells. ~~and~~ Moreover, the CDMA basic codes must be allocated to the individual radio cells of the wire-free communications device.

By way of example, European Patent Specification 0 681 776 describes a method for assigning frequencies, which in each case represent values of a transmission parameter, to base stations in a mobile radio network. ~~, which~~ The method assumes input information including ~~comprising~~ at least the number of frequencies required for each base station, the frequencies which may be used in the mobile radio network, and information relating to possible disturbance effects between the base stations in the event of associated, identical and/or adjacent frequencies. In the course of frequency assignment runs, which have to be carried

out a number of times, one base station is, in each case, selected from the set of those base stations to which all the frequencies which have been provided have not yet been assigned, with the base station being selected on the basis of a first base station selection criterion and, if necessary, further base station selection criteria. Depending on the selected base station, a frequency is selected using a first frequency selection criterion and, if necessary, further frequency selection criteria, and is then assigned to the selected base station. The frequency assignment runs are repeated until all the base stations are allocated the required number of frequencies, taking account of all the secondary conditions such as the base station and frequency selection criteria.

EP 0 565 499 A1 describes a method for allocating radio channels to base stations in a cellular mobile radio system. The allocation of the radio channels is selected such that the interference between the individual radio channels is minimized for a specific traffic load. However, the technical teaching does not relate to a mobile radio system using a CDMA multiple access method.

A method for allocating radio channels in a communications system is known from US 5,455,821, in which the communications system is based on a TDMA and/or FDMA subscriber separation method. The application of the method to communications systems which use different codes to separate the subscribers is not disclosed, however.

The present invention is thus directed toward ~~based on the object of~~ improving the provision and planning of wire-free communications networks, in particular of cellular communications networks based on a CDMA multiple access method, and on providing expansion of such communications networks. ~~The object is achieved by the features of patent claim 1.~~

SUMMARY OF THE INVENTION

~~The~~ A major aspect of the method ~~according to~~ of the present invention for allocating at least one value of at least one transmission parameter to cells in a

communications arrangement having m cells, with n different values of the at least one transmission parameter being available, is that adjacent cells are detected and each cell is in each case randomly allocated at least one value of the at least one transmission parameter. A disturbance value which represents the mutual transmission influence of the currently allocated values of the at least one transmission parameter is, in each case, determined for respectively adjacent cells, and an overall disturbance value which represents the total of all the disturbance values is then determined. The number of different values of the at least one transmission parameter and their allocation to the respective cells are varied until a minimum overall disturbance value is reached.

~~The~~ A major advantage of the method ~~according to~~ of the present invention is that it achieves very rapid allocation of ~~values of at least one transmission parameter~~ CDMA codes to cells in a communications system ~~arrangement~~ with minimal financial and technical effort and in which case, advantageously, there is no need to determine or evaluate any secondary conditions or selection criteria in advance. Advantageously, no planning considerations or subsequent further processing of considerations which have been defined in the documentation are required, so that communications systems ~~arrangements~~, in particular wire-free cellular communications networks, can be planned cost-effectively and optimized with respect to time relatively easily ~~using simple means~~. Furthermore, the method ~~according to~~ of the present invention minimizes the probability of incorrect assignments of values of CDMA codes ~~a transmission parameter~~ to the cells in the communications system ~~arrangement~~, ~~and this advantageously~~ which improves the functionality and operational reliability of the communications system ~~arrangement~~ to be provided. The method of ~~according to~~ the present invention also allows a number of CDMA codes ~~values of a number of transmission parameters~~ to be allocated to the cells in the communications arrangement.

One additional advantage of the method of ~~according to~~ the present invention is that a further disturbance value, which represents the mutual transmission influence of the currently allocated CDMA codes ~~values of the at least one transmission parameter~~, is ~~also~~ in each case determined for respectively non-adjacent cells, and the overall disturbance value which represents the total of all the disturbance values is then formed from the total, which can be weighted, of all the disturbance values and the further disturbance values~~ — claim 2~~. Accordingly ~~In this advantageous refinement~~, the process of allocating CDMA codes ~~values of the at least one transmission parameter~~ to the m cells in the communications system ~~arrangement~~ also takes account of the mutual transmission influence or disturbance between non-adjacent cells, thus further improving and optimizing the allocation of CDMA codes ~~values of the at least one transmission parameter~~ to the m cells in the communications system ~~arrangement~~, and ~~thus~~ further minimizing the susceptibility of the overall communications system ~~arrangement~~ to disturbances.

According to one advantageous development of the method ~~according to~~ of the present invention, when at least one further cell is added to the m cells in the communications system ~~arrangement~~, the allocation of at least one further CDMA code ~~value of the at least one transmission parameter~~ is carried out in such a way that those CDMA codes ~~values of the at least one transmission parameter~~ which have already been allocated to the m cells remain allocated. The total number of those CDMA codes ~~different values of the at least one transmission parameter~~ which have been allocated overall to the m cells and to the at least one cell which is added, and the allocation of at least one ~~value~~ CDMA code to the at least one cell which is added, are varied until a minimum overall disturbance value is reached ~~— claim 3~~. This advantageous development ~~advantageously~~ allows the method ~~according to the invention~~ to be used both for planning a network layout ~~— that is to say~~ (i.e., initial assignment of a CDMA code ~~a value of at least one transmission parameter~~ to the m cells in the communications arrangement) –

and for planned network expansion ~~that is to say~~ (i.e., when adding at least one further cell to the already existing m cells in the communications arrangement).

The total number of CDMA codes ~~values of the at least one transmission parameter~~ and their allocation to the respective cells are advantageously varied using an iterative optimization process, in which case the total of all the disturbance values represents a function component of a required function, which function component represents an optimization aim which can be weighted. In the course of the iterative optimization process, the optimization aim (which can be weighted) of the required function is optimized in such a way that the total of all the disturbance values reaches a minimum overall disturbance value, and the required function reaches an optimum or minimum function value ~~claim 4~~. During the iterative optimization process, known and proven optimization strategies can be advantageously ~~be~~ used for allocation of CDMA codes ~~values of the at least one transmission parameter~~ to the m cells in the communications system ~~arrangement~~. Examples of optimization strategies for iterative optimization processes are simulated annealing, genetic algorithms or ~~else~~ neural networks (Hopfield Networks) ~~claim 12~~. Iterative optimization processes are, for example, used as standard for combinational optimization problems when designing layouts of integrated circuits and are advantageously used when planning and expanding communications networks via ~~by means of~~ the method of ~~according to~~ the invention. Such algorithms for producing optimization strategies are described, for example, in the following documents:

- "Adaption in natural and artificial systems", J.H. Holland, second printing, MIT-Press, Cambridge, 1992,
- "Genetic algorithms in search, optimization and machine learning", D.E. Goldberg, Addison Wessley Publishing Company, Massachusetts, 1989,
- "Optimization by simulated annealing", S. Kirkpatrick, C.D. Gelatt, M.P. Vecchi, Science, Vol. 220, No. 4598, 1983.

According to ~~one~~ another advantageous development of the present invention, the required function has a further function component which

represents an optimization aim which can be weighted and by ~~means of~~ which the total number of those different CDMA codes ~~values of the at least one transmission parameter~~ which ~~have~~ currently have been allocated to all the cells is detected. Furthermore, the required function may have a further function component which represents an optimization aim which can be weighted and by ~~means of~~ which the total number of identical CDMA codes ~~values of the at least one transmission parameter~~ which are currently allocated to respectively adjacent cells is detected. Subsequently, in the course of the iterative optimization process, the optimization aims which can be weighted are weighted in such a manner, and the required function is optimized in such a manner, that the cells are allocated a minimum total number of CDMA codes ~~different values of the at least one transmission parameter,~~ and/or that, if possible, adjacent cells do not have identical values of the at least one transmission parameter ~~—claim 5~~. Expansion of the required function by further function components which each represent an optimization aim which can be weighted allows the allocation of CDMA codes ~~values of the at least one transmission parameter~~ to the m cells of the communications system ~~arrangement~~ to be improved and a refinement of the optimization strategy to be achieved~~,~~. This is so since, advantageously, further transmission secondary conditions can be taken into account in the planning and expansion of communications networks. As a result of suitable weighting of the individual function components of the required function, the allocation of values of the at least one parameter is advantageously carried out in the course of the iterative optimization process in such a way that the total number of those different CDMA codes ~~values of the at least one transmission parameter~~ which are currently allocated to all the cells is a minimum and, at the same time, adjacent cells are not allocated identical CDMA codes ~~values of the at least one transmission parameter~~. This results in optimum allocation of CDMA codes ~~values of the at least one transmission parameter~~ to the m cells in the communications system. That ~~arrangement, that~~ is, ~~to say~~ minimum mutual

interference between adjacent ~~values of the at least one transmission parameter,~~ and, thus, minimum susceptibility to disturbances during use of the communications system ~~arrangement~~.

At least one CDMA code ~~value of the at least one transmission parameter~~ is, for example, allocated to a central communications device which is arranged in one cell - claim 6. The central communications device may, for example, be in the form of a base station arranged in a radio cell in a mobile radio communications network.

That respective CDMA code ~~value of the at least one transmission parameter~~ which can ~~in each case~~ be allocated to a cell may, for example, represent ~~a transmission frequency or a transmission frequency band – claim 7 – or~~ an orthogonal or non-orthogonal CDMA code which can be used in the course of a CDMA multiple access method~~ – claim 8~~. The method of ~~according to~~ the present invention ~~can~~ advantageously can be used both for network planning or start-up initialization and for communications network expansion of wire-free communications networks.~~, in which~~ In such case, for example, one or more transmission frequencies or transmission frequency bands can be allocated in a particularly simple and cost-effective manner to a cell which is arranged in the wire-free communications system ~~arrangement~~. For example, the method ~~according to~~ of the present invention can be used for planning and configuration of mobile communications systems, in particular of mobile communications systems to the UMTS standard or of wire-free subscriber access networks based on a CDMA multiple access method, in which orthogonal or non-orthogonal CDMA codes or CDMA basic codes can be allocated to base stations in a very simple and cost-effective manner.

Furthermore, the cross-correlation of the currently allocated CDMA codes is, in each case, determined in order to determine the respective disturbance values which represent the mutual transmission influence of the currently allocated CDMA codes, with the overall disturbance value representing the total

of all the determined cross-correlations ~~-claim 9~~. Calculation of the cross-correlation of adjacent CDMA codes allows the respective transmission influence of the currently allocated CDMA codes to be determined in a very simple manner~~,~~; thus, further simplifying the implementation of the method of ~~according to~~ the present invention.

According to a further embodiment of the present invention ~~one advantageous refinement~~, orthogonal and/or pseudo-random CDMA codes are allocated to the central communications units, with further communication-unit-specific codes being derived from the allocated CDMA codes ~~-claim 13~~. Minimum intercellular interference between the cells in the communications system ~~arrangement~~ is achieved by deriving communications-unit-specific codes from the "optimally" allocated CDMA codes or CDMA basic codes.

The allocation of the at least one value of the at least one transmission parameter is advantageously carried out by software ~~-claim 15~~. This ~~advantageous~~ refinement allows values of the at least one transmission parameter to be allocated automatically and optimized with respect to time, with the capability to store the results obtained in a generally legible data format, so that they can be processed further by other computer programs that assist network planning.

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

~~Further advantageous refinements of the method according to the invention can be found in the further claims.~~

~~The method according to the invention will be explained in more detail in the following text with reference to a number of drawings, in which:~~

~~Figure 1A and Figure 1 B~~	~~show a cellular arrangement, which represents a network planning result, in a wire-free communications arrangement or a communications network in a supply region,~~
~~Figure 2A and Figure 2B~~	~~show a cross-correlation matrix based on non-orthogonal CDMA codes which can be allocated to the cells in the wire-free communications arrangement, and a required function, which is optimized in the course of the method according to the invention in such a way that optimum allocation is achieved, that is to say allocation with the minimum transmission influence between the available CDMA codes and the individual cells of the communications arrangement,~~
~~Figure 3A to Figure 3C~~	~~show a first result of an initial start-up assignment, carried out in the course of the method according to the invention, of the available CDMA codes to the cells in the communications arrangement, and a start value, which represents the result of the required function, based on the initial start-up assignment of CDMA codes, with the respective function components of the required function, which represent an optimization aim which can be weighted, also being shown,~~
~~Figure 4~~	~~shows a basic sequence of a combinational optimization algorithm "Simulated Annealing" whose inner loop is repeated iteratively,~~
~~Figure 5A to Figure 5C~~	~~show a final allocation result, which represents the result of the method according to the invention, of CDMA codes to the cells or base stations in the communications network, and the final result of the required functions, based on the final allocation of the CDMA codes to the cells in the communications network.~~

DESCRIPTION OF THE DRAWINGS

Figures 1A and 1B show a cellular arrangement, which represents a network planning result, in a wire-free communications system or a communications network in a supply region;

Figures 2A and 2B show a cross-correlation matrix based on non-orthogonal CDMA codes which can be allocated to the cells in the wire-free communications system, and a required function which is optimized in accordance with the method of the present invention, such that allocation is achieved with minimum transmission influence between the available CDMA codes and the individual cells of the communications system;

Figures 3A through 3C show a first result of an initial start-up assignment, in accordance with the method of the present invention, of the available CDMA codes to the cells in the communications system, and a start value, which represents the result of the required function, based on the initial start-up assignment of CDMA codes, with the respective function components of the required function, which represent an optimization aim which can be weighted;

Figure 4 shows a basic sequence of a combinational optimization algorithm, "Simulated Annealing," whose inner loop is repeated iteratively; and

Figures 5A through 5C show a final allocation result, in accordance with the method of the present invention, of CDMA codes to the cells or base stations in the communications network, and the final result of the required functions, based on the final allocation of the CDMA codes to the cells in the communications network.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1A shows a communications system ~~arrangement~~ KA which is arranged in a supply region and, in this exemplary embodiment, represents a wire-free communications network based on a CDMA multiple access method; ~~-~~for example, a wireless local loop system "WLL" based on CDMA technology. As a result of network planning, which ~~has~~ already has been carried out and will not be explained in any more ~~any more~~ detail, the wire-free communications network is subdivided into four radio cells ~~or cells~~ Z1...4, for example depending on the terrain characteristics of the supply region, with~~, in this exemplary embodiment,~~ a central communications device or base station BS1...4 having ~~with~~, for example, integrated omnidirectional antennas being arranged in each cell Z1...4. The

dimensions and the respective arrangement of the individual cells Z1...4 and the positioning of a base station BS1...4 within a cell Z1...4 are defined accurately by the result of the network planning which has already been carried out, and are illustrated in Figure ~~figure~~ 1A. The topology of the wire-free communications network KN illustrated in Figure ~~figure~~ 1A, and the arrangement of the individual cells Z1...4 of the communications network KN are shown in an adjacency graph G which is illustrated in Figure ~~figure~~ 1B, with each base station BS1...4 corresponding to one, and only one, node K1...4 in the adjacency graph G. Each edge, which connects two respective nodes K1...4, in the adjacency graph G in each case represents two adjacent cells Z1...4 or base stations BS1...4 which, at least partially, have a common boundary profile. For example, as shown in Figure ~~figure~~ 1B, the first and the fourth nodes K1,4 are connected by one edge and, in consequence, the first and the fourth base stations BS1,4 are identified as being adjacent. In a corresponding way, Figure ~~figure~~ 1A shows the common boundary profile between the first and the fourth cells Z1,4. Furthermore, as shown in Figure ~~figure~~ 1B, the first and the second base stations BS1,2, together with the second and fourth base stations BS2,4 and the second and third base stations BS2,3 are identified as being adjacent. No edge is arranged in the adjacency graph G between the first and the third nodes K1,3, since the first and the third cells Z1,3 and the wire-free communications network KA do not have any common boundary profile – see Figure ~~figure~~ 1A.

In order to allow optimum operation, that is to say disturbance-free operation, of the communications network KA designed using a CDMA multiple access method, each base station BS1...4 arranged within a cell Z1...4 in the CDMA communications network KA must be allocated one or more base-station-specific CDMA codes or CDMA basic codes c1...7 – see Figure ~~figure~~ 2A. ~~, with the~~ The aim is, ~~being~~ as far as possible, to avoid or minimize any mutual influence or interference between CDMA codes c1...7 allocated to adjacent cells Z1...4. By way of example, the following text describes the allocation of one, and only one,

CDMA code c1...7 to a base station BS1...4. The CDMA codes c1...7 must be allocated to the cells Z1...4 in the CDMA communications network KA in such a way that the value of the intercellular noise which represents the mutual interference between the CDMA codes c1...7 is a minimum. In this exemplary embodiment, seven global, non-orthogonal CDMA codes C1...7 are available for configuration of the CDMA communications network KN illustrated in Figure ~~figure~~ 1A, and these are at least partially intended to be distributed optimally to the base stations BS1...4 arranged in the CDMA communications network KA in the course of an initial code assignment process~~,~~; that is, ~~to say~~ during the initial assignment of CDMA codes c1...7 which represents the setting up of the network.

Figure 2A illustrates the cross-correlation matrix KC, which is symmetrical about the main diagonal, of the CDMA codes c1...7 to be allocated in this exemplary embodiment, with each cross-correlation value kc1_1...kc7_7 represented in the cross-correlation matrix KC in each case representing the mutual influence, dependency or interference between two CDMA codes c1...7. The values kc1_1, kc2_2, ..., kc7_7 arranged on the main diagonal of the cross-correlation matrix KC each have the value 1, since identical CDMA codes c1...7 each have a maximum dependency or correlation. Since, in this exemplary embodiment, both orthogonal and non-orthogonal CDMA codes are to be allocated to the individual cells Z1...4 in the CDMA communications network KA, those correlation values which are not arranged on the main diagonal of the cross-correlation matrix KC also, in some cases, have a value other than 0. For example, as shown in Figure ~~figure~~ 2A, the first and the fifth CDMA codes c1,5 have no dependencies; - that is, ~~to say~~ the first and the fifth CDMA codes c1,5 are orthogonal with respect to one another - and, in consequence, the corresponding value kc1_5 in the cross-correlation matrix KC has the value 0.

According to the present invention, the available CDMA codes c1...7 are allocated to the respective cells Z1...4 in the CDMA communications network KA using a required function E which is to be optimized and which is illustrated in

Figure ~~figure~~ 2B. In this exemplary embodiment, the required function E has three function components f1...3, which each represent an optimization aim which can be weighted and are each improved iteratively in the course of the method of ~~according to~~ the present invention by using a combinational optimization algorithm, so that the required function E is optimized overall. The first function component f1, which is weighted with a first weighting factor k1, is used to detect the number of different CDMA codes c1...7 allocated to the cells Z1...4 in one allocation step. Furthermore, a function component f2, which is weighted with a second weighting factor k2, in the required function E defines the number of identical allocated CDMA codes c1...7 in adjacent cells Z1...4, and a function component f3, which is weighted with a third weighting factor k3, in the required function E forms the total of those cross-correlation values c1_1...c7_7 of allocated CDMA codes c1...7 which are arranged in adjacent cells Z1...4 in the CDMA communications network KA. According to Figure ~~figure~~ 2B, the first weighting factor k1 has the value k1 = 1000, the second weighting factor k2 has the value k2 = 2000, and the third weighting factor k3 has the value k3 = 1000.

Based on the method of ~~according to~~ the present invention, the available CDMA codes c1...7 are allocated randomly to the cells Z1...4 or base stations BS1...4 in the CDMA communications network KA in a first allocation step, which is referred to as the initial allocation. The random allocation of the CDMA codes c1...7 may be carried out, for example, using a random-selection method. Figures ~~Figure~~ 3A and ~~figure~~ 3B show the result of the initial allocation of CDMA codes c1...7 to the base stations BS1...4 in the communications network KA, and to the nodes K1...4 in the adjacency graph G. After the first, initial allocation step, the first base station BS1 is allocated the fifth CDMA code c5, the second base station BS2 is allocated the sixth CDMA code c6, the third base station BS3 is allocated the second CDMA code c2, and the fourth base station BS4 is likewise allocated the second CDMA code c2. Figure 3C shows, in a self-explanatory manner, the result of the required function E, based on the initial

allocation of the CDMA codes c2,5,6 illustrated in Figure ~~figure~~ 3A, with the origin of the results of the individual function components f1...3 being shown in more detail. The value of the required function E illustrated in Figure ~~figure~~ 3C and based on the initial allocation represents, according to the present invention, the start value of the required function E = 6260. The ~~, with the~~ required function and, thus, the start value is ~~being~~ iteratively improved or optimized in the course of the method ~~according to the invention~~ by using the combinational optimization algorithm which is referred to as "simulated annealing". A fundamental "simulated annealing" sequence is shown in a self-explanatory manner in the form of a flowchart in Figure ~~figure~~ 4.

The combinational optimization algorithm is repeated, that is to say the number and the allocation of the CDMA codes c1...7 are varied in such a way, until the required function E, and/or the respective function components f1...3 of the required function E which represent an aim which can be weighted, are optimized and a termination criterion which can be predetermined is reached. On reaching the termination criterion, - for example when the required function E reaches a minimum final value, - the current allocation of at least some of the available CDMA codes c1...7 is stored as the final result. By way of example, Figure ~~figure~~ 5A shows the final, that is to say "optimum" allocation of CDMA codes c1...7 to the base stations BS1...4 in the form of a table, with this allocation having been determined using the combinational optimization algorithm. According to the optimum allocation, the first base station BS1 is allocated the fifth CDMA code c5, the second base station BS2 is allocated the first CDMA code c1, the third base station BS3 is allocated the fifth CDMA code c5, and the fourth base station BS4 is allocated the sixth CDMA code c6. The final allocation of the CDMA codes c1,5,6 is likewise shown in the adjacency graph G illustrated in Figure ~~figure~~ 5B. Figure 5C shows the corresponding required function E based on the determined, "optimum" allocation of the CDMA codes c1,5,6 to the base stations BS1...4, with the partial results for the three function components f1...3 of

the required function E being explained in more detail. The final value of the required function E = 3040, which is illustrated in Figure ~~figure~~ 5C and at the same time represents the termination criterion, in this case represents the minimum value determined by using the combinational optimization algorithm – see Figure ~~figure~~ 3C.

The described method resulted in the communications arrangement KA illustrated in Figure ~~figure~~ 1A, and the base stations BS1...4 arranged in the CDMA communications network, being allocated a minimum number of different CDMA codes c1...7 – (allocation of only three different CDMA codes c1,5,6) - with adjacent base stations BS1...4 or radio cells Z1...4 not having the same or identical CDMA codes c1...7 and, at the same time, the sum of the cross-correlations kc1_1...kc7_7 of the CDMA codes c1,5,6, allocated to adjacent base stations BS1...4, having a minimum value. The allocation of CDMA codes as shown in Figure ~~figure~~ 5A, which represents the final result of the method of ~~according to~~ the present invention, thus has the least mutual interference influences. This~~; this~~ allocation is thus regarded as the optimum~~,~~ and is stored in a generally legible data format. The stored final result ~~can~~ advantageously can be processed further by ~~means of~~ other computer-based network planning tools.

In addition, the described method ~~can~~ also can be used to allocate values for other transmission parameters, such as radio frequencies or frequency bands, to the respective cells Z1...4 in the communications system ~~arrangement~~ KA.

In addition, the method of ~~according to~~ the present invention ~~can~~ also can be used during network expansion, that is to say when further radio cells or base stations – (not shown) - are added to an already existing communications arrangement KA. In such ~~, in which~~ case, those values of a transmission parameter which ~~have~~ already have been allocated to base stations BS1...4, - for example already allocated CDMA codes c1...7, - remain allocated~~,~~ and at least one value of the at least one transmission parameter, - for example a CDMA code c1...7 or CDMA basic code, ~~–being~~ is allocated only to the newly added base

stations, by using the combinational optimization algorithm in each case. For example, in the event of a network expansion, a stored, optimum result of an allocation is read in, and base stations BS1...4 to which at least one value of the at least one transmission parameter has already been allocated are provided with a marking in the course of the method. A marking can be provided, for example according to one refinement variant indicated in Figure ~~figure~~ 5B, by setting a flag, - for example a set bit, - in a marking data field mdf or in a marking memory cell which is in each case allocated to one node K1...4 in the adjacency graph G. Each node K1...4 in the adjacency graph G ~~may~~ also may be allocated a further value memory cell wdf for storing the at least one allocated value of the at least one transmission parameter; - for example, the allocated CDMA code c1...7 – see Figure ~~figure~~ 5B. Each flag which is allocated to a node K1...4 or to a base station BS1...4 in a marking data field mdf indicates whether a value which is stored in the corresponding value memory cell wdf may be changed in the course of the method. For example, when setting up a network or during initial allocation of values of the at least one transmission parameter, all the marking data fields mdf are erased, and at least one value of the at least one transmission parameter is thus allocated to each node K1...4 and to each base station BS1...4. In the event of a network expansion or when adding further base stations to an already existing communications system ~~arrangement~~ KA, the already allocated values of the at least one transmission parameter are read in or loaded, and the flags are set as appropriate in the marking data fields mdf. The method of ~~according to~~ the present invention results in the added base stations being treated in the same way as when the network is set up. The already allocated values of the at least one transmission parameter are advantageously retained since, for example, a considerable time penalty and financial cost are involved to locally change CDMA codes c1...7 which ~~have~~ already have been allocated to base stations.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be